Review of paper: Accounting for model error in air-quality forecasts: an application of 4DEnVar to the assimilation of atmospheric composition using QG-Chem 1.0

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General

This paper explores the idea of using the 4DEnVar approach for chemical data assimilation (DA). That method is currently widely used for NWP, but as explained, chemical DA stills relies on simpler approaches such as 3DVar or objective analysis. This is done in the context of a much reduced (toy) system defined by two layers and a limited domain. However a comprehensive chemistry model is used. The paper is well written and demonstrates the author's excellent understanding of key issues on the current state of chemical DA. Results are well presented, showing the added value expected from 4DEnVar as well the possibility to account for model errors. I recommend publication after addressing the minor points below.

Minor points

It seems that are tests are done setting to zero inter-species error correlation. While some justification is provided for this, perhaps an actual figure would help. For example on p. 23 it is said: "Finally, 4DEnVar was capable to provide same good results as in Sec 4.1.1 when enabling the cross-variables covariances". Results are not shown to back this statement?

It is said that "Only surface observations are considered in this study" (p13, L28). There is a need to acknowledge as well the lack of vertical propagation of information from these surface variables in the context of the "toy" system. This represents a significant challenge in a real system.

Typos:

P3 line 6: "Next day", not "next day)

P5 L6" "This allows", not "allow"

P18 L 18, correct typo "Multimultivariate-variate" ?

P 19 L 16: "lifetime", not "life-time"

P23 L3: "this also justifies", not "justify"

P28 L 6 " Apart", not " A part"